Pest Profile Updated 10/9/2010

Common Name: South American spongeplant (spongeplant, frogsbit)
Scientific Name: *Limnobium laevigatum* (Humb. & Bonpl. ex Willd.) Heine
Family: Hydrocharitaceae

Distribution and spread in California

Counties: Fresno, Madera, Merced, Shasta. Recent Pest and Damage Reports place it also in Contra Costa, Sacramento and Stanislaus Counties; those Counties await listing pending their placement in regulations.

South American spongeplant first appeared in California in 2003 in two small, isolated locations. For several years it was limited to those locations and thus appeared likely to not spread much. In 2007 it appeared for the first time in a moving water situation. Since then it has expanded inexorably, despite having a seven-person state crew attacking each new find, and despite the ready assistance of most irrigation districts when they are informed of its presence in their canals. Spongeplant is relatively easy to control, at least in situations where it has not established a seed bank, but is proving to spread readily.

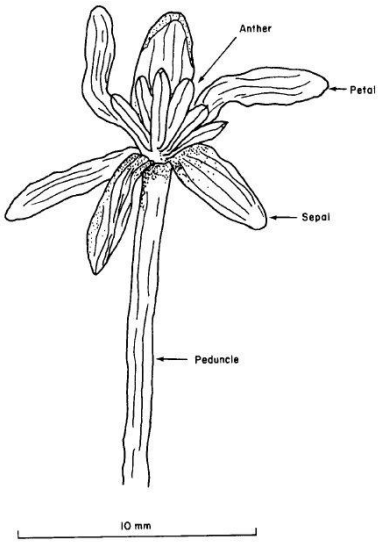
Background: The plant is native to Central America, South America east of the Andes, and to some islands of the Caribbean. Its discovery in California is a new U.S. record. There are few mentions of the plant outside its native range. There is no mention in Reed and Hughes (1977). Randall (2002) and the Internet-based Global Compendium of Weeds mention only its being naturalized in Chile. It had been sent to German botanical gardens in the late 1800's and noted as an escape in West Java in 1967 (Diaz-Miranda et al., 1981). Its recent spread and strong growth in California, however, indicate that it should be of serious concern here.

Description: *Limnobium* species are aquatic floating herbs which grow in dense floating mats or rooted in mud on wetland edges. Under crowded growing conditions they are easily mistaken for water hyacinth, although they are much smaller on average, usually only 8 to 12 inches in height. There are only two *Limnobium* species, *L. laevigatum* and *L. spongia*. They are very similar to one another and to the closely related species *Hydrocharis morsus-ranae* L. (also often called frogsbit).

A few easily seen differences distinguish *H. morsus-ranae* from the *Limnobium* species (Hrusa, 1999). Flowers of both *Hydrocharis* and *Limnobium* are unisexual and the plants are monoecious: staminate (male) and pistillate (female) flower parts are on separate flowers, but male and female flowers can form on the same plant. Staminate flowers of both genera have sepals and petals, while the pistillate flowers may or may not have petals. In *Hydrocharis* the petals are showy and generally at least 1.5 times the length of the sepals while *Limnobium* petals are generally no longer than the sepals and not showy.

The two genera are easily confused when no flowers are available, but leaf shape can distinguish them. In *Limnobium* the leaf changes form according to age and crowding: young or uncrowded plants have leaves that float flat on the water, with a slightly heart-shaped base and the leaf stem shorter than to a little longer than the leaf blade (Figure 1). Older, crowded plants hold their leaves vertically. Also, the leaf has a tapered base and a long stem, often five times or more the length of the leaf blade. *Hydrocharis* leaves always remain of the floating type, flat on the water. When in the flat, floating form typical of uncrowded conditions, *Limnobium* leaves are still distinctly different from Hydrocharis leaves, when viewed edge-on. *Limnobium* leaves are very thick at the base, then curve and taper rapidly to the tip, giving the leaf profile a strongly keeled shape. The keel is formed by a pad of large air-filled chambers (aerenchyma) that help the plant float; the aerenchyma also puts the "sponge" in "spongeplant". *Hydrocharis* leaves are not strongly keeled or tapered, and are only slightly thickened when compared to leaves of other plants (similar to the upright

leaves of *Limnobium*). Roots of *Limnobium* are dimorphic (branched), while those of *Hydrocharis* are monomorphic (unbranched).



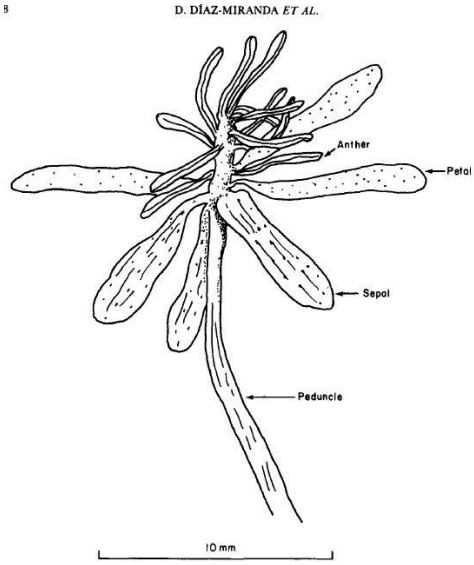


Figure 1. Upper left: So. American spongeplant, crowded form. Lower left: uncrowded form. Note showy white female flower. Upper right: male flower of *L. laevigatum*. Lower right: male flower of *L. spongia*.

Limnobium spongia and *L. laevigatum* are more difficult to distinguish. The most reliable characteristic is stamen number (male flower). Generally there are six stamens in *L. laevigatum* and 9-12 in *L. spongia*. However, care is needed in finding the male flower. The female flower is showy and easily seen, with long, pale filaments radiating outwards and upwards from the flower base (Figure 1, lower left). These filaments are the pistils, and since flowers on many other plants have just one to a few pistils while they have many stamens, these multi-pistillate flowers are easy to mistake for male flowers. The male flower is drab and requires careful search to find. In the absence of flowering material leaf tip shape is useful; the leaf tip is more or less acute (pointed) in *L. spongia* but decidedly rounded in *L. laevigatum*. Otherwise these two species are very similar.

Habitat: South American spongeplant is similar in many ways to water hyacinth. Spongeplant mats develop best in slow or still waters, sheltered from the wind. The plants normally float but they will root in the mud at

the water's edge. In its native habitat, it is most common in shallow, near-shore areas of seasonally flooded ponds or lakes, in back channels adjacent to rivers (Santos and Tomaz, 2008, Willink et al, 2000, Fortney et al., 2004). However, in California we have seen that the small plants can find shelter along the edges of even fast-moving rivers, such as the San Joaquin in the vicinity of Fresno. In California, mats form readily in ponds and slower-moving sections of canals or streams. In its native habitat, it occurs from sea level, where it is most common, up to 6500 feet in central Mexico and to 8500 feet in Columbia (Cook & Urmi-Konig, 1983). In California, we have found it growing vigorously along the north coast in Arcata, and in the Central Valley from its northern extreme in Redding, south to Fresno. It is also growing in the western Sacramento Delta near Antioch, in or near the areas where salt intrusion from the tides becomes a factor.

Life Cycle: There is little information in the scientific literature on the species. It is a perennial herb. Like water hyacinth, mats can increase rapidly in size through vegetative reproduction, that is, by budding off new plants. In Figure 1, lower left, a small plant can be seen developing on a stolon coming from a more mature plant. Unlike hyacinth, however, spongeplant also reproduces from seed. For hyacinth, seedlings are rare or unknown in many infestations. In contrast, in California we have observed spongeplant producing abundant seed pods and seedlings. Flowering and seed set appears to be heaviest as the weather warms in May and early June, at which time flowers can be very abundant, but flowering continues into the fall. The flowers are held above water and pollination is probably via wind. The seeds are shed above water, but germinate underwater. The seedlings then float to the surface and grow. Individual seeds are covered with small spinules and the seeds when shed are contained in a gelatinous mass (Cook & Urmi-Konig, 1983). The young seedlings are small, scarcely 1/8th inch across, making them hardly larger than duckweed plants (Figure 2). The seeds and young seedlings are so small that they could easily stick to waterfowl or watercraft. The small plants hide easily among other vegetation and find shelter readily along the edges of even fast-moving streams. The survival time of seeds is not known, but at the Redding and other ponds, seedlings are still appearing although we have almost completely suppressed the populations for three years.

Figure 2: Spongeplant seedlings (in red ellipses) mixed with duckweed.

Uncrowded plants, as noted, have the leaves floating flat on the water and the leaves are generally small, one to three inches across. As they become more crowded, the plants grow vertically, and they typically reach a mature size of 8 to 12 inches. The leaves change shape from the uncrowded to the crowded morphology, as noted in the Description.

Damage: Damage is likely to be very similar to water hyacinth, as the two plants are so similar that they are often confused with one another. Damage is caused by the heavy mat, which smothers the water surface,

crowds other species, and blocks access to the water. The huge volume and mass interfere with the movement of water and contribute massive quantities of organic matter which must be handled by the natural carbon and nutrient cycles. The mats also alter the ecological niches that are available to the natural community.

The above characteristics cause various damages to people and the environment. As for people, the heavy mats make fishing or boating difficult or impossible, causing serious damage to recreation and tourism, if not actually interfering with shipping and trade. The mats move with the current and pile up wherever there is an obstruction. They therefore accumulate in infrastructure for moving water, and will likely jam weirs, dams, gates, and siphons, as well as being pulled into pumps where they will jam and damage the machinery. During high water, they may increase flood risk by piling against obstructions and clogging the channel. The mats should also provide good mosquito habitat, presenting a health threat.

Spongeplant's seeds and small plants present a further threat that is lacking in hyacinth. In hyacinth, a daughter plant, newly released from its parent, is already typically three to six inches across and four to ten inches tall. At present, water diversion facilities can often exclude water hyacinth from their forebays and their facilities, by setting up booms or screens that shunt the large hyacinth plants downstream past the intake locations for their systems. Such measures probably will not work against the small seedlings and certainly not the submerged seeds of spongeplant. It will probably spread more easily and be more difficult to exclude than hyacinth. Evidence for this is its presence in separate irrigation systems both east and west of Fresno, scattered over miles of canals. By contrast, there is essentially no hyacinth in those canals.

Survey Methods: The only method of survey is by visual searching. Booms or other obstructions will concentrate the plants and make them easier to find in canals and other running water.

Management: For moderate numbers of isolated plants or patches up to a few yards in diameter, removal by hand or nets is effective. For large mats, canal excavation equipment or herbicides are effective. In our experience, the most effective herbicide is diquat (Reward), which is effective at ¼ label rates (2 oz. per gallon) (also, Madsen et al, 1998). Other effective herbicides include glyphosate (Aquamaster) with Competitor surfactant, 2,4-D (Weedar), triclopyr (Renovate), and penoxsulam (Galleon) (operational observations and L. Anderson, pers. comm.). No treatment is known for the seed bank, and the difficulty of removing a population appears to depend strongly on whether a seed bank has established.

Economic Impact: Potential economic impacts are unknown but may be greater than water hyacinth's, as spongeplant appears to have the potential to be a more widespread and persistent nuisance. In recent years, the Department of Boating and Waterways has spent about $1.6 to 1.8 million per year for direct control of water hyacinth, but that is in the Delta alone. Most canal systems in California are kept nearly clean of hyacinth, yet we are already seeing spongeplant appear in canals where hyacinth is essentially absent. Since spongeplant is a floating plant, it could become a persistent nuisance in concrete-lined canals as well as earthen ones, and therefore may present a problem in the major water delivery infrastructure of the state. Similarly, it may be a problem in reservoirs and forebays connected to the delivery system, where water depth and changes in water level normally exclude rooted, submerged water plants. If spongeplant reduced water delivery by even a few percent, it would represent tens of millions of dollars in economic activity.

Environmental Impact: The environmental impact of spongeplant should, again, be similar to or somewhat worse than water hyacinth. Individual spongeplant plants are much smaller than hyacinth plants, so the mats are packed much tighter. Hyacinth mats have a perhaps 50 to 100 plants per square meter, while the spongeplant mat in the Redding pond had about 2500 plants per square meter before treatment. Spongeplant mats therefore seal the water's surface at least as completely as hyacinth mats, and probably much more so. In the Redding pond before treatment, the spongeplant crowded out all the parrotsfeather and most of the water primrose, both of which are considered aggressive competitors and weeds in their own right. The mat was so cohesive that grass had begun to grow on part of it, so the pond might have soon been transformed into a meadow.

Aside from excluding competitors, including native plants, spongeplant will likely cause low dissolved oxygen levels and high biological oxygen demand beneath its mats, due to the abundant organic matter, which will

also affect pH and nutrient cycling. This will cause fish populations to fall and may limit other aquatic animals, such as insects and crustaceans. The mats will deny open water to waterfowl.

The growth rate of spongeplant mats apparently will be similar to or greater than water hyacinth (*Eichhornia crassipes*), at least in open situations. In its native range, spongeplant is a common and abundant plant, although it is not usually dominant. That distinction is held by another hyacinth, *E. azurea*, and the waterfern *Salvinia auriculata* (Santos and Tomaz, 2008, Willink et al, 2000, Fortney et al., 2004). However, spongeplant has a relative growth rate approximately twice as high as the water hyacinth here in California (E. *crassipes*) and similar to *S. auriculata* (Marques-Silva and Tomaz, 2009). In competition tests with other native South American floating water plants, spongeplant was a better competitor than *S. auriculata* but not as good as water lettuce (*Pistia stratiotes*) (Milne et al., 2007). However, in California, water lettuce has not survived the winter in the area of the Delta, while spongeplant continues to spread readily. As water hyacinth can outcompete water lettuce (Agami and Reddy, 1990), spongeplant may be limited in some locations by competition in California, even if it has shown itself capable of crowding out some aggressive competitors here.

Methods of Spread: The plants spread easily with moving water. Waterfowl will probably pick up and move the small seedlings and sticky seeds. Like most aquatic plants, spongeplant is easily spread by boats or boat trailers.

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